Prolonged Stress in SEALAB II: A Field Study of Individual and Group Reactions*

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Digest

This study was an investigation of individual and group reactions to extreme, prolonged stress in a field situation. The study was conducted as part of Project SEALAB II, a U. S. Navy experiment to determine if divers could survive and work for periods of 15 to 30 days 200 feet underwater enduring the ambient pressure at that depth.

The 28 divers completed a number of personality and demographic questionnaires prior to submersion. While underwater, they filled out mood-adjective checklists and were continuously monitored by closed-circuit audio and television circuits.

Divers underwater were significantly more fearful and aroused than on the surface prior to submersion. The three 10 men teams which lived together underwater became significantly more cohesive after submersion.

Evaluation of sociometric choices of leaders indicated that age and maturity were the only characteristics associated with being chosen as a leader. Performance, fear, arousal, gregariousness and choice as a peer were not related to leader choice.

No increase in the homogeneity of emotional responses was found over time.

Self-reported fear and arousal were significantly correlated with performance criteria. The more frightened and aroused divers demonstrated inferior performance.

First-born and only children were significantly more frightened and showed significantly poorer performance than later-borns.

Failure of an individual to share in group activities and social behavior was associated with higher levels of reported stress and inferior performance.

Using six predictors in a multiple regression, it was possible to account for 50% of the variance on each of three objective performance criteria.

Advantages and disadvantages of field and laboratory investigations of stress were discussed and suggestions for future research advanced.

ACKNOWLEDGMENT

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The nature of man's reactions to extreme conditions of psychological stress has long been a major concern of psychology. The importance of the research area stems from the need to understand human behavior in such critical and prevalent situations as war, natural disaster, and hazardous vocations and avocations. Such situations are implicitly defined as stressful because the individual's physical well-being and safety are threatened by environmental contingencies. This implicit definition can be extended to classify as stressful all conditions where threat of physical danger exists and is perceived, and a high degree of emotional tension is involved.[1]

Investigations of human reactions to stress have been of two general types, both beset with severe methodological deficiencies. The first approach consists of field studies of naturally occurring stressful events. This type of study customarily employs clinical observations during the period of threat and/or interviews of participants outside the stressful environment. An extensive literature of such research exists (cf. Bettelheim, 1943; Glass, 1954; Glover, 1942; Grinker & Spiegel, 1945; Janis, 1951, 1958; Melita Schmideberg, 1942; Stouffer et al., 1949; Wolfenstein, 1957; Disaster Research Group, 1961). This research suffers from the necessarily uncontrolled nature of the research environment and from the usual inability of investigators to make systematic observations over time of the behavior of individuals while they are experiencing real stress. The field setting also makes the evaluation of human performance under stress extremely difficult because objective criteria of performance

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[1]See Appendix A

are rarely available.

The second general approach is to stress subjects in a laboratory setting in which the environment can be rigidly controlled and measures of social behavior and performance easily collected. (Berkowitz & Cottingham, 1960; Darley & Aronson, 1966; Goldstein, 1954; Grossack, 1954; Helmreich & Collins, 1966; Holtzman & Bitterman, 1956; Janis & Feshback, 1953, 1954; Lanzella & Roby, 1956; Lazarus & Ericksen; 1952; Leventhal & Singer, 1965; Miller & Zimbardo, 1965; Sarnoff & Zimbardo, 1961; Schachter, 1959; Zimbardo & Formica, 1963.)

All of the studies mentioned are uni-cultural. Systematic cross-cultural studies of performance under stress have not yet been undertaken.

Two characteristics inherent in the laboratory-experimental approach severely limit the generality of findings and can offset the advantages gained from controlled experimentation.

First, it is ethically impossible to induce a <u>level</u> of stress in a laboratory study comparable to that found in naturally occurring stressful situations (such as combat, disasters, flying, deep sea diving, etc.). Indeed, subjects rightfully believe that an experimenter will not expose them to undue risk or permit permanent damage to befall them.

Second, a condition of prolonged stress cannot be maintained in the laboratory. It is impossible to keep a subject in a state of high stress for an extended period to observe changes in behavior over time. Even in studies of some duration, the subject customarily has the option of terminating the experience at will. As a result, laboratory investigations typically deal with the momentary effects of stress rather than

reactions to prolonged stress. Field studies have reported that although initial exposure to stress may not lead to cognitive disorganization, physical deterioration, repression and social withdrawal may appear after extended periods of stress. (Grinker & Spiegel, 1945; Sobol, 1947; Janis, 1963.)

Investigators, both in field settings and in experimental laboratory research, have been concerned with the effects of stress on similar phenomena. These interests cluster in three major areas.

1. Group behavior. Stress affects the relationship of an individual to a primary group. Desire for affiliation and group identification have been found to increase under stress (Fritz & Marks, 1954; Grinker & Spiegel, 1945; Helmreich & Collins, 1966; Janis, 1951, 196 ; Miller & Zimbardo, 1965; Schachter, 1959; Shils & Janowitz, 1948; Melita Schmideberg, 1942; Stouffer et al., 1949; Zimbardo & Formica, 1963). Increases in dependency and increased salience of group leaders have been observed frequently (Bettelheim, 1943; Glover, 1942; Grinker & Spiegel, 1945; Helmreich & Collins, 1966; Janis, 1958, 1963). Widespread increases in conformity to group norms are also reported (Grinker & Spiegel, 1945; Janis, 1951, 1963; Stouffer, et al., 1949).

2. Performance under stress. Widely differing findings on the effectiveness of performance under high stress abound. In some cases stress appears to facilitate, in others to impair performance, while differential effects are sometimes reported on tasks of differing complexity; and no stress effects on performance are reported in some studies (Fleishman, 1958; Hardison & Purcell, 1959; Lanzetta, 1955; Lazarus &

Ericksen, 1952; Murphy, 1959; Ross, Rupel & Grant, 1952; Zimny, 1956).

3. Individual differences in reactions to stress. Many studies report differences in tolerance for stress and behavior in stressful situations as a function of background or personality variables (Davidson, Andres & Ross, 1956; Deese, Lazarus & Keenan, 1953; Fenichel, 1945; Janis, 1958; Lazarus, Deese & Hamilton, 1954; Lucas, 1952; Schachter, 1961; Spence, Farber & Taylor, 1954).

Goals of the Study

The present study was an attempt to minimize the limitations inherent in both the laboratory and field approaches to stress research. A field setting was chosen which placed subjects under extreme stress for an extended period of time for reasons other than psychological research. Subjects in the military groups studied were in a constant and circumscribed environment throughout their exposure to stress and were continuously and systematically observed through the use of remote audio and video monitors. As all participants had similar and defined work tasks, it was possible to employ objective criteria of performance and to relate these to background and situational variables. The present study thus differs from the more typical field investigation of behavior under real stress in being conducted in a controlled environment where systematic observations of behavior and performance could be made for a prolonged period.

Hypotheses

Because of the global nature of the field setting, an attempt was

made to structure the research by limiting the study to the evaluation of a number of specific a priori hypotheses. The following predictions were made:

1. An individual's reported level of stress should be related to his performance. It has been proposed by Janis and Leventhal (1966), that performance is related to the intensity of stress as an inverted U-shaped function. According to this hypothesis, moderate levels of stress should facilitate performance because of increased vigilance and arousal, while extremely high levels of stress should result in impaired capacity for judgment and action. It is predicted that in a situation of prolonged, high stress, individuals reporting the highest levels of stress should show the greatest performance deficit.

2. No specific predictions concerning personality variables are advanced. However, based on experimental studies of stress reactions (Helmreich & Collins, 1966; Schachter, 1959; Zimbardo & Formica, 1963) and reports of performance effectiveness in combat (Schachter, 1960; Torrance, 1954), it is predicted that first-born and only children will perform less effectively under the high stress conditions present in this study. There should also be a tendency for first-borns to experience more fear under the stressful conditions of SEALAB.

3. As proposed by Collins and Guetzkow (1964, p. 142), "Under conditions of common fate, individuals will develop interpersonal attraction." This should be reflected in increased group cohesiveness. The stressful nature of SEALAB should strengthen this effect as increases in attachment to the primary group are widely reported in field studies

of stress. (Grinker & Spiegel, 1945; Janis, 1951; Melita Schmideberg, 1942; Stouffer et al., 1949.)

4. Failure on the part of an individual to share openly in the emotional reactions of the group will result in an impairment of his subsequent performance and adjustment. This is based on the assumptions that the group provides reassurance under stressful conditions (Wrightsman, 1960) and that sharing group reactions may provide "emotional inoculation" (Janis, 1951, 1953) against the debilitating effects of stress. The widely reported increase in conformity to group norms under stress (Grinker & Spiegel, 1945; Janis, 1951; Stouffer, et al., 1949) may make the group more sensitive to deviant behavior and may lead to the rejection of deviates. Sharing of group reactions should be reflected in directing most attention to group interaction rather than communication with the surface, participating in group tasks and orientation towards others.

5. Individuals facing stress should show increased dependency on the leader who provides a source of support and reassurance. This is based on clinical reports that the presence of trusted leaders may mitigate threat (Stouffer, et al., 1949; Wispé & Lloyd, 1955) and experimental findings that a leader assumes additional salience under threat (Helmreich & Collins, 1966). This should be reflected in increased sociometric evaluation of the leader and concern with reassurance by the leader.

6. Continued exposure to stress should result in increased homogeneity of emotional responses. This is based on the assumption that sharing of affect and social comparison of individual reactions

(Festinger, 1954) should cause a reduction in the heterogeneity of responses. Two conditions may prevent increased homogeneity of response under stress: (a) Extremely high levels of stress may result in behavioral disorganization and (b) prolonged exposure to stress may produce similar breakdown.

Method

Overview of the Study

The research was undertaken in conjunction with Project SEALAB II, a field investigation of deep diving connected jointly by the Office of Naval Research and the Special Projects Office of the Navy Department. The Navy's goal in the project was to determine the feasibility of placing men underwater to work at great depths for extended periods of time.

The importance of exploring man's ability to remain submerged under a pressure equal to that of the surrounding water comes from the necessity to decompress slowly after experiencing a pressure greater than one atmosphere (33 feet of depth). Diving time per day is severely restricted by the fact that a man must undergo a long decompression to avoid the formation of gas embolisms (the "bends") after remaining underwater for more than a few minutes, thus limiting useful working time. The period of time required to decompress initially increases exponentially with both depth and duration of submergence.[2] Research on diving, however, has

[2]Representative decompression times are: 15 minutes at 190 feet - 17.8 minutes decompression; 60 minutes at 190 feet - 232.3 minutes decompression (U. S. Navy Diving Manual, 1963).

disclosed that during a prolonged exposure to pressure at a fixed depth, a diver's tissues become completely saturated with breathing gases (Naval Research Reviews, 1965).[3] Consequently, after saturation occurs, the required decompression time remains fixed regardless of the length of the dive. Thus, if divers can be maintained in an undersea habitat in which the internal pressure is equal to the ambient pressure of the water, they can have free and unlimited access to the sea. Only one decompression is required on final return to the surface. This capability drastically improves the ratio of working time to decompression time and makes it possible to attempt lengthy projects at considerable depth. SEALAB II sought to test these ideas by placing teams of divers underwater in a pressurized habitat from which they could work on a number of undersea tasks.

Equipment and Research Environment. The underwater habitat was a 12' x 57' steel cylinder divided into a working and recreation area, a galley, and a bunk area with sleeping facilities for ten men. The habitat was equipped with 11 viewing parts looking into the water. Access to the sea was through a 36" hatch in the deck of the capsule. As the internal pressure was maintained equal to the ambient pressure of the water outside, the hatch remained continuously open to the sea. The interior arrangements of the habitat are illustrated in Figure 1.

Electricity, breathing gases and communications were provided from the surface through an umbilical cable attached to a support vessel

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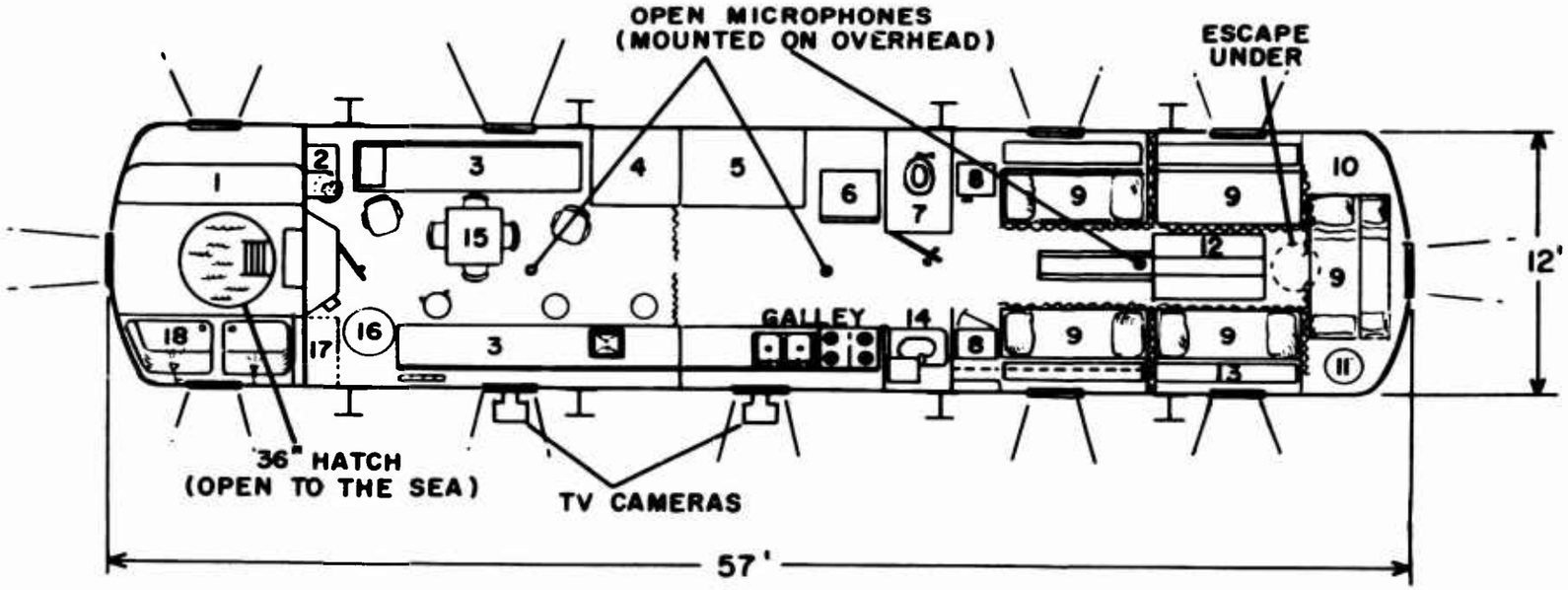
[3]The period required for saturation at 200 feet is believed to be between 12 and 24 hours.



1. Swim gear stow
2. TV
3. Lab bench
4. Fan room
5. Electric power and light
6. Reefer
7. Head
8. Locker
9. 2-Berths
10. Stow.
11. Co can.
12. Table
13. Bench
14. Lav.
15. Table and chairs
16. Water heater
17. Can stow'g.
18. Tub and shower

SEALAB II
INTERIOR ARRANGEMENT
TOP REMOVED-LOOKING DOWN

FIG. 1

moored directly over the habitat. A second connection giving alternative support led from the capsule to shore based facilities. Supplies were exchanged between the surface and the habitat in pressurized containers lowered by a trolley system. The arrangement of support facilities is shown in Figure 2.

The SEALAB capsule was placed on the Pacific Ocean bottom at a depth of 205 feet one mile offshore at the Scripps Institution of Oceanography, La Jolla, California. The ambient pressure, at which the habitat was maintained, varied between 98 and 104 pounds per square inch (approximately 7 atmospheres) dependent on the state of the tide. The bottom topography in the SEALAB setting is illustrated in Figure 3.

Water temperature at the 200 foot depth of SEALAB ranged from 46°F to 50°F. The average visibility on the bottom was 10 to 20 feet.

The breathing gas mixture with which the capsule was pressurized consisted of approximately 78% helium, 18% nitrogen and 4% oxygen. This mixture was employed because normal concentrations of oxygen became toxic when breathed under pressure, causing convulsions and pulmonary disease and the ordinary percentage of nitrogen (78% at sea level) produces narcosis ("rapture of the depths") under pressures greater than one atmosphere.[4]

The SEALAB program. Three 10 man teams of divers participated in the project. The first team lived in the capsule and dove daily in the water outside for 15 days. At the end of this period, 9 divers returned to the surface while 1 remained below for a second 15 day period and was

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[4] The effective concentration of oxygen for breathing was approximately 28% higher than the sea level atmosphere, because of the 7 atmospheres pressure.

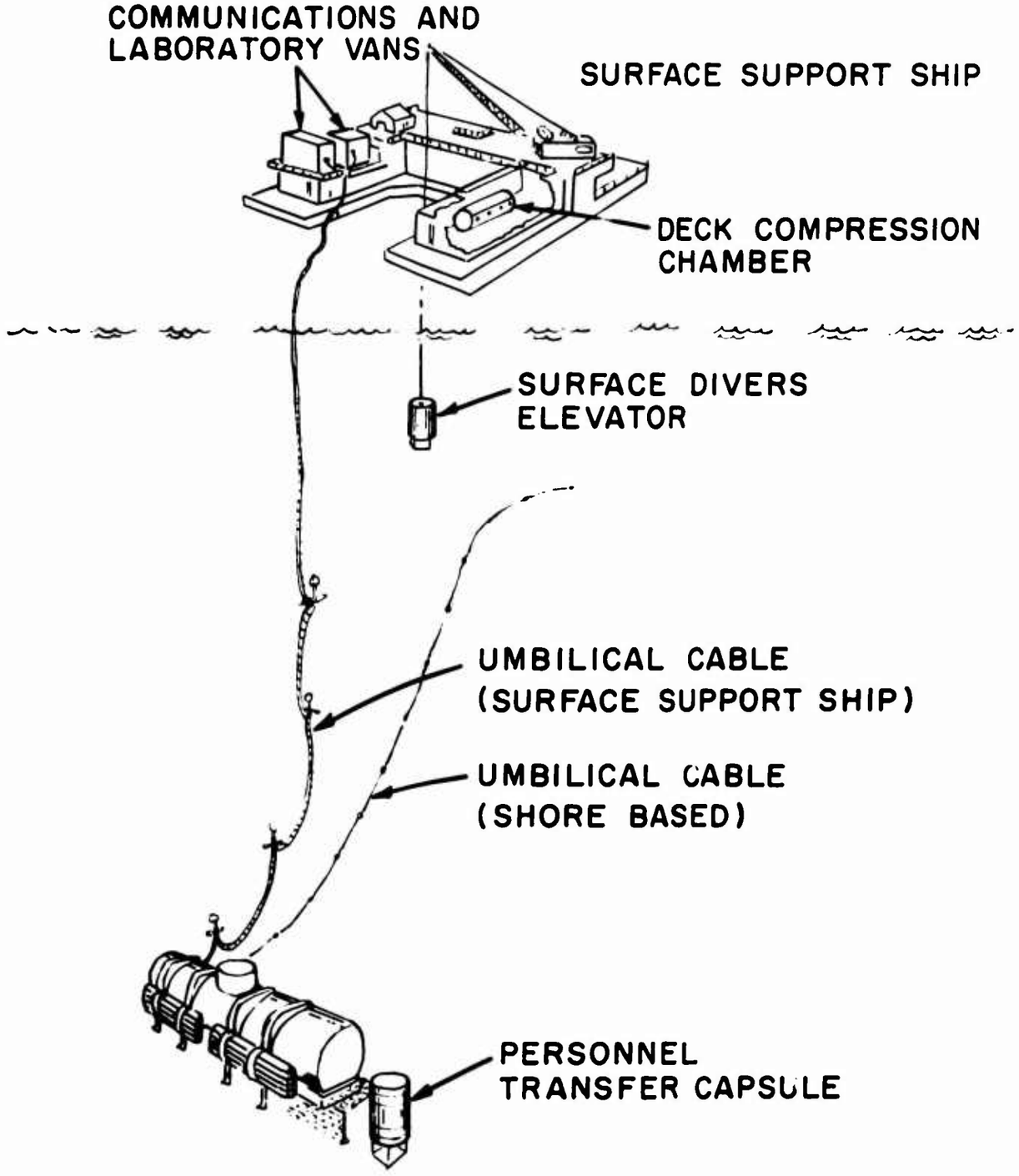
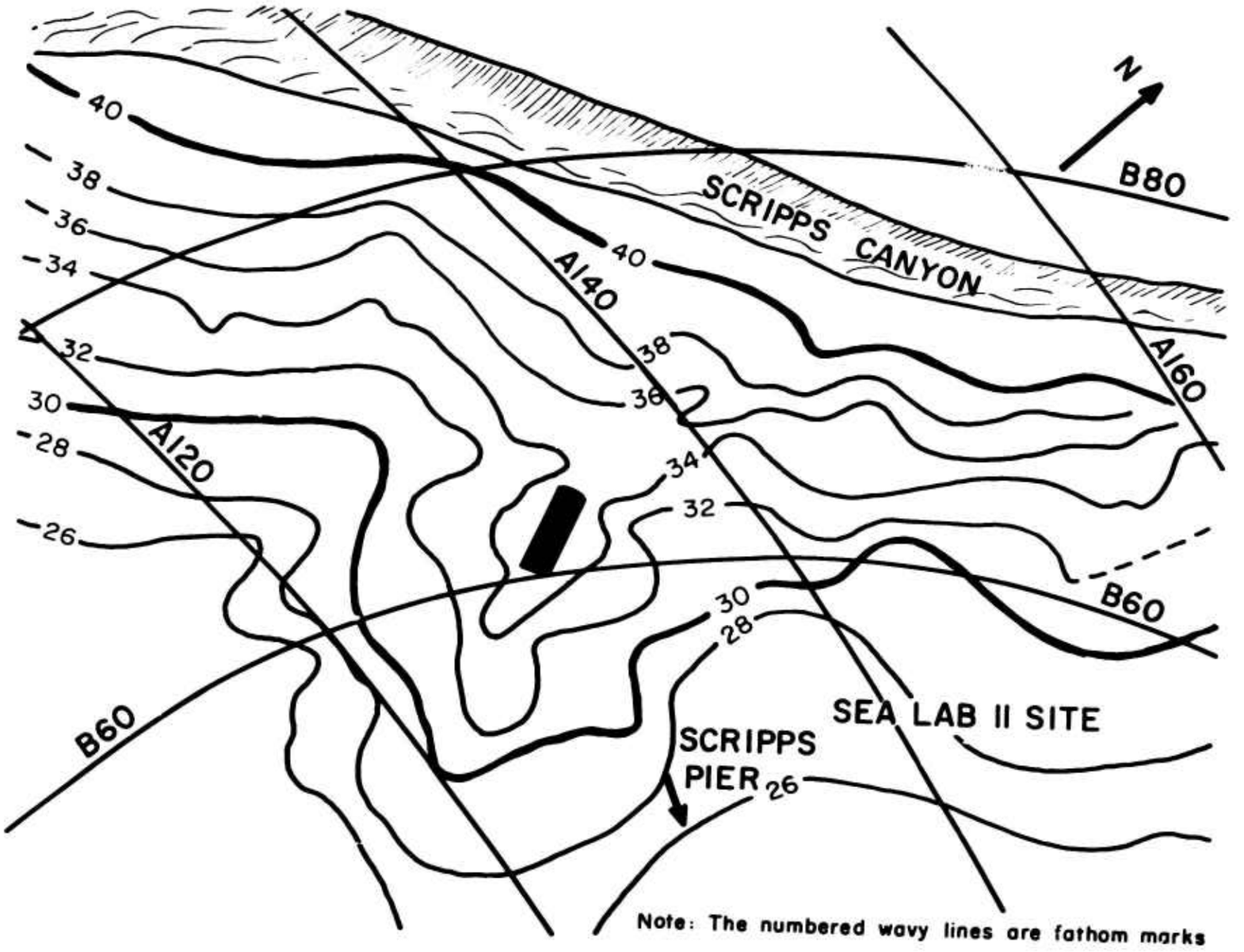

COMMUNICATIONS AND
LABORATORY VANS
SURFACE SUPPORT SHIP
DECK COMPRESSION
CHAMBER
SURFACE DIVERS
ELEVATOR
UMBILICAL CABLE
(SURFACE SUPPORT SHIP)
UMBILICAL CABLE
(SHORE BASED)
PERSONNEL
TRANSFER CAPSULE

FIG. 2


N
B80
SCRIPPS CANYON
A140
A160
A120
B60
B60
SEA LAB II SITE
SCRIPPS PIER
40
38
36
34
32
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28
26
40
38
36
34
32
30
28
26
Note: The numbered wavy lines are fathom marks

FIG. 3

joined by 9 members of Team 2. After 15 days, the 10 divers surfaced and were replaced by Team 3 which was composed of 9 new divers and one diver who had spent 15 days submerged with Team 1.

Surfacing was accomplished by swimming to a Personnel Transfer Capsule maintained at the ambient bottom pressure. The capsule was then sealed, raised to the surface and mated to a Deck Decompression Chamber. Once on the surface, the men were gradually decompressed to atmospheric pressure, a process which took approximately 36 hours. This equipment is pictured in Figure 2.

The stated goal for teams underwater was for each man to spend as much time as possible working in the water outside the capsule in Self Contained Underwater Breathing Apparatus (SCUBA). The Navy compiled a list of 47 in-water projects for accomplishment during SEALAB. These projects included evaluation of new underwater equipment, studies of marine life, underwater photography, oceanographic surveys, construction projects, use of trained porpoises for underwater work, perceptual, visual and acoustic experiments, performance evaluation tests and underwater salvage projects. The number and scope of projects assigned was far in excess of the divers' capability to achieve, but provided some freedom for the aquanauts in choice of mission and ensured that no one would be left unoccupied.

Stressful aspects of the SEALAB environment. The importance and usefulness of the SEALAB project as a setting for the study of reactions to stress can best be emphasized by enumerating the conditions which made the underwater environment extremely hazardous and uncomfortable

for every aquanaut.

The sea at 200 feet is an unforgiving adversary. The water, at 46 to 50 degrees F, was cold and debilitating to a diver. Visibility was poor, ranging from zero to 30 feet at best. This limited visibility made it necessary to follow guidelines stretched on the bottom and the risk of becoming lost was ever present. Once lost, a man away from SEALAB would be at the mercy of the limited air supply of his SCUBA equipment, as there was no chance to surface -- the normal response of a diver in an emergency. To surface would mean instant death as each man was saturated with gas under seven atmospheres pressure. The only safe haven was the 36" diameter entrance hatch to SEALAB.

Divers were continuously exposed to the risk of a painful and incapacitating sting from one of the thousands of poisonous scorpion fish surrounding the habitat. Many divers experienced such a sting.

The diving equipment used by the aquanauts was a constant source of danger. The breathing apparatus used is delicate and complex and subject to a variety of malfunctions. A number of equipage failures occurred without warning, placing the diver in real danger and adding to the pervasive sense of threat associated with each sortie from the habitat. Adding to this hazard was the fact that verbal communications between divers or between divers and the habitat were impossible as no working in-water communications systems were available.

Life inside the SEALAB capsule was also fraught with peril. There was a constant danger that an object lowered from the surface might smash one of the glass parts or that a rupture of the thin-walled capsule might

occur, subjecting the aquanauts inside to instant death by drowning.

Aside from physical danger, living and working conditions inside the capsule were frustrating, uncomfortable and stressful. Life for ten men and their equipment inside a 12 x 57 foot cylinder was crowded in the extreme. There was no privacy and no place to stow personal effects out of the way. In addition, the habitat sat unevenly on the bottom with a list of six degrees in two directions. As a result, drawers would slide open or shut and objects would slide off of counters and tables. Moving about in the capsule required walking up or down hill while leaning sideways.

The helium gas mixture provided for breathing seriously disrupted verbal communications. The lightness of the helium atmosphere gave voices a "Donald Duck" quality and made comprehension of speech very difficult. The helium atmosphere also made smoking an impossibility.

The fact that the capsule was open to the water made the humidity inside the capsule uncomfortably high. This discomfort was augmented by the rapid heat transfer characteristics of the helium atmosphere. Largely as a result of the high humidity, most aquanauts suffered from ear infections and skin rashes.

There was no escape from this environment for the disaffected aquanaut. To surface without decompression was to die, making the aquanauts as effectively isolated as space crews. The final transfer to the surface for decompression was one of the most hazardous aspects of the project. There was a real threat of damage to the transfer capsule and depressurization during raising which would have meant immediate death.

Even after returning to the surface, the long process of decompression had to be endured with its danger of embolish (bends) -- an eventuality which occurred for one diver.

There is no doubt of the objective threat of the SEALAB environment. However, it is vital to verify that the aquanauts perceived the stressfulness of their underwater experience. Perhaps the most effective way to convey the diver's feelings and to give the flavor of life 200 feet beneath the surface is to quote the men themselves as they describe their 15 days underwater in individual tape-recorded de-briefings.

Commander M. Scott Carpenter, an aquanaut who had previously been the second man to orbit the earth during Project Mercury, described the underwater environment as "more hostile than outer space."

Aquanauts were acutely aware of the fact that they could not surface. As one put it,

> "There is that apprehension there and in the back of your mind you know that you've got to be careful. You know you get a chance to make <u>one</u> mistake out there and that's it. You're at 100 feet and you run out of air or something like this, and boy, you run into real trouble, you can dump your gear and head for the surface. And this is what a diver nearly tends to do. The first thing you get into trouble where you need, you know you got to breathe, you dump your gear, your weights and you head for the surface 'cause you know there's air out there. But down here we couldn't head for the surface...."

Another diver puts it more strongly,

> "You spent 75% of your energy thinking on your chances and the other 25% on what you would do if you had a malfunction and you keep checking your gear. Anybody can make a free ascent from 200 feet to the surface, but after you're saturated, you can only get to this little bitty hole and so you think -- you can't go no place when you get up [to the surface] 'cause you <u>know</u>

you're going to die if you go."

Working in the water has its own special character.

> "I think it's a function of stress -- I did things in the water that didn't reflect good judgment, good forethought. It takes a long time to do things in the water and I don't know why. You don't move as fast, first of all. You get tired sooner -- you get cold sooner. You can't see as well. You've got gloves that interfere with your manual dexterity. Things float away -- lines get in your way -- you get your gear fouled in equipment and you worry about stepping on the fish [scorpion fish]."

The poisonous scorpion fish were accepted as a real threat.

> "I was scared of those fish. I don't like the idea of going out there and getting zapped and not knowing if the effects of that fish are going to prevent you from getting back inside the lab because you can get stung like that and go into a type of fit. I don't like the idea of this so I was always in fear of touching the bottom. Then you could see those fish out there -- like stones -- like a cobblestone street. Wasn't a space of more than 4 or 5 inches from one fish to another."

A diver describes his feelings about the SCUBA equipment used.

> "I don't feel confident about any piece of equipment that delicate. So I have a great respect for the Mark VI (the diving rig) and I am scared of it which is the thing to be."

That apprehension about equipment was justified can be seen from reports of emergencies such as this one:

> "I took a lung full of air and I just didn't have any. I grabbed onto the hose and I looked toward the surface and I tried again to breathe and there just wasn't a drop of air coming out there. Well, I could see the hose floating up and I could see it was kinked but there was no way in the world I could unkink it so all I did was I rolled over, pointed my head down and straightened my legs out and I really headed for the entryway. I remembered thinking while going back 'I hope that hose don't hang up' because if that hose

> hung up on something I'd of never, never made it back. Well I, I laid down in my bunk that night and I thought about this. Just say I got four feet from that shark cage and it did get fouled, what would I do? I think I was pretty close to a panic stage 'cause I was hard in prayer when I did hit the entryway."

The same man reports assisting another diver whose suit became over-inflated and started to carry him to the surface.

> "When I got him I got hands on the manifold of the Mark VI and I didn't know how bad he was hurtin' but I know that he was in a state of panic, and I took and grabbed him and I tried to jerk him off that line. Well I didn't have strength enough to jerk him off that line. I was swimming free and by kicking all I could I could not break him free of that line so I kept holding him down until he got to SEALAB and when he let go of the line to grab onto SEALAB I got a little control over him. I pulled him toward the entryway and I swam with him, bodily swam with him all the way up into the entryway. By that time I was completely exhausted."

The rescued diver reports his reaction.

> "I didn't lose confidence in the Mark VI -- I lost confidence in myself. I gave serious thought to this. I just took a shower and I think I hit the sack and got out of the way -- just thought the situation over for awhile. I thought the best thing for me to do is not to try to dive any more that day -- it was getting late in the day anyway -- and think this thing over and try to do it again tomorrow. Talk it over with (<u>another</u> diver) -- what he saw the problem as, etc., which we did and I was quite apprehensive about the next dive. I was quite relieved when everything went well and that dive was over."

An aquanaut reports running out of air.

> "I was in a hurry and I got about 30 feet away from SEALAB and I took a breath of air and got nothing, but my bag collapsed. So I started heading back and I got real woosy -- rockets started going off

and I didn't think I was going to get back in. "

Another diver inhaled some carbon dioxide absorbent from his diving rig.

> "I had been out I guess about one half hour -- we were placing some more lights. I got a lung full of something -- started to cough. I did everything to cough my mouthpiece out. I had to swim back to the shark cage and came in which is a good thing I did because by the time I did I was coughing up blood with it. I was spitting -- someone said 'you're spitting blood.' I said 'it can't be.' When I looked at it it was a pinkish color. It took me quite awhile to realize that I was coughing up blood. It took me a good 10 hours to stop coughing."

The danger of becoming lost in the dark water was constant and real.

> "This was the most exciting moment, I think. When we had been following a line out and got well out of sight of the SEALAB and the line was buried periodically and all. We were surrounded by scorpion fish and followed out -- turned around and the lights were gone and there was all of this turbidity that we had stirred up.... So I sank to the bottom and began feeling around for this line and couldn't find it. So we swam in the direction we knew it should be, through the turbidity, and eventually ran into the visibility range and there was a line that we followed."

Another man reports a similar experience.

> "One other time I definitely got lost. I wasn't familiar with the spot. I went out to look for the visual range and I became completely confused there. It seemed like a long, long ways before we even ran into that visual range. I became lost there and they hadn't set up a line to it yet. The only thing I found then was that cable to the beehive. I went back along that cable. I was confused there."

The coldness of the water added to the experience also.

> "The cold creeped up on you very fast. I won't say it got unbearable -- it wouldn't be to the point

> that if an emergency arose you couldn't have stayed there. Now if somebody said 'O.K. this, it's important, you can stay 5 more minutes' you could have did it. But you had that feeling of wanting to get back in there.... I got the shakes mostly when I came into the laboratory. If I was working out there I wasn't shaking bad. I made some 106 minute swims and I wasn't shaking that bad out there where, like I said, where it was unbearable. But once you got up in the entry-way, like if say you come up and sat down for a few minutes while the pots were being loaded, you'd get started shaking uncontrollably. You weren't that cold, I mean you weren't that uncomfortable, but you just couldn't stop shaking."

There were rewards, too, however. An aquanaut describes his feelings about descending to 300 feet.

> "That [300 feet dive] was my highlight -- personal highlight -- it was a test of guts, there's no doubt about it. Damn right. It was total darkness -- there's no doubt -- it couldn't have got any darker. It was a nice thing to know that I did have the intestinal fortitude to go out there and do it."

The Psychological Research Program. The psychological research reported was undertaken on a non-interfering basis with the program described above. This approach was particularly advantageous in that the aquanauts did not in any sense regard themselves as subjects in a psychological study, but rather as participants in a project of underwater explorations and research. Divers were told that the psychological research was simply one part of the overall study of "Man in the Sea." As one aquanaut put it during de-briefing "We were motivated to do a good job and that [the psychological testing] was part of a good job." As a result, the divers' performance presumably was little influenced by perceptions that they were being studied and evaluated by psychologists.

The study had three main aspects. (a) The collection of background

and personality data through paper and pencil tests given all subjects prior to submergence. (b) Evaluation of the reactions and behavior of each team during submergence through continuous direct observation using closed circuit audio and video monitors on the bottom, self-report measures filled out by the divers and objective measures of performance and adjustment. (c) Collection of post-stress reactions through interviews and paper and pencil tests.

Subjects

Subjects were 28 experienced divers who volunteered for participation in Project SEALAB II. They were chosen by the U. S. Navy operational commander on the basis of diving ability and work specialties. No psychological testing or selection criteria were used in the selection of aquanauts. Eighteen aquanauts were career Naval personnel while ten were civilians.

Background Data

During the training period after selection but prior to submergence, subjects completed a number of pencil and paper measures of demographic and personality variables. Demographic variables collected were age, years of diving experience, ordinal position in family and size of home town. The subject population was remarkably heterogeneous with an age range of 24 to 49 years, a range of diving experience of 2 to 28 years and a level of education running from less than ninth grade to graduate degrees.

No significant differences between teams on these background variables

DD Form 1473

12. SPONSORING MILITARY ACTIVITY

Office of Naval Research

13. ABSTRACT

This study was an investigation of individual and group reactions to extreme, prolonged stress in a field situation conducted as part of Project SEALAB II. The 28 divers completed personality and demographic questionnaires prior to submersion. While underwater, they filled out checklists and were continuously monitored by closed-circuit audio and television. Divers underwater were significantly more fearful and aroused than on the surface prior to submersion. The three 10 men teams which lived together underwater became significantly more cohesive after submersion. Evaluation of sociometric choices of leaders indicated that age and maturity were the only characteristics associated with being chosen as a leader. Performance, fear, arousal, gregariousness and choice as a peer were not related to leader choice. Self-reported fear and arousal were significantly correlated with performance criteria. The more frightened and aroused divers demonstrated inferior performance. First-born and only children were significantly more frightened and showed significantly poorer performance than later-borns. Failure of an individual to share in group activities and social behavior was associated with higher levels of reported stress and inferior performance. Using six predictors in a multiple regression, it was possible to account for 50% of the variance of each of three objective performance criteria.

14. KEY WORDS

SEALAB
Stress
Performance
Mood
Leadership
Sociometric choice
Group cohesion
Birth order
Shared affect

were found. Scores on demographic variables by team are shown in Table 1. The other crucial contrast, between civilian and military divers, revealed that they differed only with respect to educational level -- civilians had completed significantly more years of education than military divers. Means on demographic variables for civilians and Navy personnel are shown in Table 2.

Background factors. An antisocial behavior index was constructed from background questions dealing with violations of social norms. Nine scales employed in research with personnel wintering-over in the Antarctic were also employed (Gunderson, 1966). These included scales measuring Insolence, Achievement Motivation, Autonomy, Succorance, Compulsivity, Need for Activity, Maturity, and Delinquency. Items comprising these scales are listed in Appendix B. In addition, the Allport-Vernon-Lindsey Scale of Values was administered.

A one-way analysis of variance contrasting the three teams on each of the scales was performed. No significant Fs were found, indeed, none reached the 10% level of significance. Comparisons were also made on these variables between the civilian and military subgroups. Here significant differences were found only on the Autonomy Scale (military showing greater expression of Autonomy), the Need for Activity Scale (military showing more need for action) and the Theoretical Scale of the Allport-Vernon-Lindzey (civilians placing a higher value on theoretical issues). In general, then, the three teams showed no differences and the civilian and military subgroups showed few differences on any of the background dimensions investigated. Means for the teams and the civilian-military

Table 1

Overall and Team Means on Demographic Variables

	Overall Mean	Team I	Team II	Team III
Mean Age	35.14	35.20	35.44	34.78
S. D.	5.52	6.20	3.47	6.89
Mean Years Diving Experience	10.96	9.40	9.89	13.78
S. D.	5.84	6.50	3.92	6.24
Educational Level[a]	5.25	5.50	5.78	4.44
S. D.	1.97	1.96	1.92	2.00
Ordinal Position[b]	1.71	1.70	1.67	1.78
S. D.	0.90	0.95	1.00	0.83
Size of Hometown[c]	2.93	3.20	3.00	2.56
S. D.	1.27	1.32	1.12	1.42
Anti-social Behavior	5.25	4.70	4.78	6.33
S. D.	1.76	1.06	1.99	1.80

[a]Educational level was scored on a 9 point scale with 1 = less than 9th grade, 9 = graduate degree

[b]Ordinal position was scored on a 3 point scale with first-born and only children = 1, middle-born = 2 and last-born = 3

[c]Size of home town was scored on a 6 point scale with 1 = less than 1000, 6 = greater than 500,000

Table 2

Means for Civilian and Military Subgroups on Demographic Variables

	Overall	Civilian (N = 10)	Military (N = 18)
Mean Age	35.14	32.10	36.83
S. D.	5.52	5.93	4.62
Mean Years Diving Experience	10.96	8.60	12.28
S. D.	5.84	4.62	6.14
Educational Level[a]	5.25	6.95	4.01
S. D.	1.97	2.24	2.06
Ordinal Position[b]	1.71	1.70	1.72
S. D.	0.90	0.95	0.90
Size of Hometown[c]	2.93	3.00	2.89
S. D.	1.27	1.41	1.23
Anti-social Behavior	5.25	4.70	5.56
S. D.	1.76	1.34	1.92

[a] Educational level was scored on a 9 point scale with 1 = less than 9th grade, 9 = graduate degree

[b] Ordinal position was scored on a 3 point scale with first-born and only children = 1, middle-born = 2 and last-born = 3

[c] Size of home town was scored on a 6 point scale with 1 = less than 1000, 6 = greater than 500,000

contrast are given in Appendix C.

Sociometric measures. After training, but before beginning the SEALAB submergence, each aquanaut was asked to fill out two sociometric questionnaires. He was asked to list in order the five men he would most prefer as team leader and the five men he would most prefer as team mates. Subjects were not limited to choosing out of their 10 men teams but were told to restrict their sample population to men in training for SEALAB (this population included the 28 SEALAB divers and 7 support divers). Using this technique, it was not only possible to obtain sociometric scores for each man, but also to judge group cohesiveness by measuring the number of choices made within and outside one's own team.

Table 3 lists all pre-dive variables.

Observational Procedures During Dive

Behavioral monitoring. Continuous video and audio monitoring of behavior inside the SEALAB habitat was achieved through remote receivers from two T.V. cameras located in the capsule (in the work area and in the galley area) and through three open microphones (in the work area, galley and bunk area).[5] Camera and microphone placement is shown in Figure 1.

Twelve college student observers had been recruited through the Navy Neuromedical Psychiatric Research Unit in San Diego and were trained in observational techniques. The student observers were not aware of the hypotheses being tested and were not informed of the meaning attached to

[5] To provide a minimum degree of privacy, no TV camera was mounted in the bunk area, although audio monitoring was possible.

Table 3

Summary of Pre-dive Measures

1. Age
2. Years of diving experience
3. Educational level
4. Ordinal position
5. Size of home town
6. Anti-social behavior index
7. Insolence Scale
8. Achievement Motivation Scale
9. Autonomy Scale
10. Succorance Scale
11. Compulsivity Scale
12. Need for Activity Scale
13. Maturity Scale
14. Delinquency Scale
15. Sociometric Choices of Leader
16. Sociometric Choices of Team Mate

the variables they were asked to record. Two observers were on duty from 7 a.m. to 10 p.m. throughout the dive and one observer between 10 p.m. and 7 a.m. In addition, either the author or Dr. Roland Radloff of the Navy Medical Research Institute was present 24 hours a day throughout the 45 day duration of the project.

The following variables were scored during the dive:

1. Order of arising. The order in which each man arose was recorded daily.

2. Mood on arising. Observers rated the mood of each diver on a 5 point scale when he arose.

3. Gregariousness. The location of each man in sight of either TV monitor and the number of men with him were recorded every 30 minutes from 7 a.m. to 10 p.m. daily. From this variable a gregariousness index was computed for each man by summing the frequency of being in the company of every other man and dividing by the number of observations.[6]

4. Mood. Observers rated the mood of each man on camera every thirty minutes between 7 a.m. and 10 p.m.

5. The gross activity level of each man not diving was calculated by observing the number of times every man passed into or out of the field of the camera located in the galley. This was measured for eight 30 minute periods per day starting at times 0730, 0930, 1130, 1330, 1530, 1730, 1930, and 2130.

6. Communications initiated to the surface. The only communications

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[6] If a man was off camera, but his location known (either in the bunk area or diving) an observation was counted. If his location was unknown, no observation was recorded.

access to the surface other than to Navy personnel on the support vessel was through a telephone line connected to a shore based switchboard. The switchboard was continuously manned and the number of calls initiated by each man was recorded daily.

7. Time up during the night. Scheduled sleeping hours were 10 p.m. to 7 a.m. Every 15 minutes from midnight until 6 a.m., subjects who were active and out of bed were observed. From this a daily index of time up was computed by summing the number of 15 minute blocks in which a subject was up.

8. Helpfulness. The number of times a man assisted in the preparation of meals or clean-up after meals was recorded daily.

Instructions and scoring for observational variables are presented in Appendix C.

Failures in In-Capsule Observation. It was planned to collect data on a number of variables connected with verbal communications. The distortion in verbalization induced by the helium atmosphere doomed this aspect of the research. While general comprehension of speech was possible, localization of speech and identification of speakers proved nearly impossible and attempts at systematic observation were abandoned.

Self-Report Data. Divers filled out a 67 item mood checklist every other day during submergence. The checklist was developed in research on Navy recruits and had been factor analyzed into six scales using 1800 military personnel as a sample (Myers, 1966). The a priori scales employed were (1) Anger, (2) Happiness, (3) Fear, (4) Depression,

(5) High Arousal and (6) Lethargy. Items forming the scales and their scoring are presented in Appendix D.

Performance Measures. Aquanauts were given a superabundance of projects to complete, and one of the major goals of the SEALAB program was to determine how much diving a man could achieve while living underwater. Since the number and duration of dives were largely determined by the individual, the diving actually achieved by each man provided objective indices of performance. The following a priori measures of performance were employed:

1. Diving time. The amount of time spent by each man in the water outside the SEALAB capsule daily.

2. Number of sorties. The number of times per day that each diver entered the water.

3. Number of performance tests completed. Each diver was asked to conduct a number of simple manual tests in the water as part of research conducted by the Engineering Psychology Branch, Office of Naval Research. These included pulling on a torque wrench and recording foot-pounds of force exerted, assembling small metal triangles with nuts and bolts and a test of two-handed co-ordination. The number of these tasks completed and reported by each man daily was recorded.[7]

Blocking of data collected during submersion. Data from each item were condensed into five day blocks. Intermittent failures of TV cameras

[7]It was originally planned to use performance on these tasks as variables, but the number of identical tests completed by all divers was so small that no valid indices could be constructed.

and underwater relay links caused some repetitive observations to be missed. However, the random occurrence of these failures and the large number of observations per five-day period makes the block mean a reliable measure. A list of the variables collected while divers were underwater with the average number of observations per block is presented in Table 4.

The average score for each diver over the three blocks was computed and this composite score was employed for comparisons with pre- and post-submersion measures.[8]

Post-submersion Measures

After returning to the surface and completing decompression, each diver was interviewed and completed several post-questionnaires:

1. A second sociometric test was completed by each aquanaut. Choosing from the same total population of SEALAB personnel used in the pre-dive measures, divers were asked to list in order the five men they would most prefer as leader and the five men they would most prefer as team mates if they were to participate in another SEALAB project.

2. A post-SEALAB questionnaire was filled out by all divers. Seven a priori scales were constructed from this questionnaire. These scales were:

(a) Dissatisfaction with experience

(b) Enjoyment of recreation

(c) Work effectiveness

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[8] For the two divers who were members of two teams, the average of their scores on the two teams was used. Performance by these men on both teams was quite consistent.

Table 4

Summary of Measures Obtained During Dive

	Variable		Method Collected	Mean Number of Observations per man per 5 day block
1.	Order of arising		observation	5
2.	Mood on arising		observation	5
3.	Gregariousness		observation	93
4.	Mean mood		observation	93
5.	Activity level		observation	37
6.	Daily total of communications directed to surface		direct recording/ observation	4
7.	Amount of time up between midnight and 6 a.m.		observation	128
8.	Number of times assisting in preparation of meals		observation	14
9.	Anger Scale	Mood Checklist	self-report	2
10.	Happiness Scale		self-report	2
11.	Fear Scale		self-report	2
12.	Arousal Scale		self-report	2
13.	Lethargy Scale		self-report	2
14.	Diving time - daily total		objective report	5
15.	Number of dives - daily total		objective report	5
16.	Number of psychological performance tests completed		self-report	5
17.	Time in work area		observation	93
18.	Time in galley area		observation	93

(d) Physical disability

(e) Importance of work orientation for SEALAB divers

(f) Importance of interpersonal orientation for SEALAB divers

(g) Index of relative importance of work and interpersonal orientation for SEALAB divers.

Items forming posttest scales, their scoring and the average inter-item correlations are presented in Appendix E.

3. Leader ratings. Team leaders were asked to rate each member of their teams on a 7 point scale as to work effectiveness and diving ability. These ratings were summed and a Leader Evaluation score computed for each diver. Post-dive variables are summarized in Table 5.

Results and Discussion

A number of variables listed in the Methods section are not discussed in this section as results are limited to a priori hypotheses. They were included in the listing to give an indication of the scope of the study and to specify the context in which the measures used in this report were gathered.

Perceived Stressfulness of SEALAB II

A check was made on the perceived stressfulness of the SEALAB experience by comparing responses on the Fear and Arousal scales of the mood checklist completed prior to submergence with the average of responses made during the days underwater. The results strongly emphasize the stressfulness of life at 200 feet underwater. 28 of 28 men reported higher fear underwater. A t-test on individual difference

Table 5

Summary of Post-dive Variables

1. Sociometric Choices of Leaders
2. Sociometric Choices of Team Mates
3. Dissatisfaction Scale
4. Enjoyment of Recreation Scale
5. Work Effectiveness Scale
6. Physical Disability Scale
7. Work Orientation Scale
8. Interpersonal Orientation Scale
9. Index of Work versus Interpersonal Orientation

scores showed a significantly higher level of fear underwater, $t = 6.64$, $p < .001$, $df = 27$.[9]

Similar results were found for the Arousal scale. 24 of 28 aquanauts reported being more aroused while in SEALAB, the remaining 4 showed no change in arousal. Again, the t test on difference scores shows a significantly higher level of arousal in SEALAB, $t = 6.97$, $p < .001$, $df = 27$.

It is clear, then, that the stressful nature of life in SEALAB emphasized by the aquanauts in post-submersion interviews is supported by their responses to a mood-adjective checklist. Results of the pre- and during-submersion mood comparison are summarized in Table 6.

Group Reactions in SEALAB

1. Changes in group cohesiveness. The hypothesis that sharing the "common fate" of the SEALAB environment would result in increased group cohesiveness was strongly supported by the sociometric data. The index of change in cohesiveness employed was the difference in sociometric choice of fellow team members between the pre- and post-submersion administration of the team mate sociometric questionnaire. A t-test was performed on the individual difference scores. The results show a highly significant increase in choices of team mates after the 15 day immersion ($t = 4.095$, $p < .005$). Sociometric means are presented in Table 7.

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[9]All p values reported throughout are two-tailed.

Table 6

Fear and Arousal Scores prior and During Submersion

	Fear	Arousal
Prior to Submergence	20.94	17.16
Mean Score during Submergence	24.96	20.32

Table 7

Means for Sociometric Choice of Team Mates[a]

Overall Means (N = 28)

Pre-dive	Post-dive	Mean Difference
4.892	8.321	+3.428

t = 4.095 p < .005

Team Means (Team N = 10)

Team	Pre-dive	Post-dive	Mean Difference
I	4.70	10.20	+5.50
II	2.90	5.10	+2.20
III	6.60	9.90	+3.30

[a]Sociometric choices were weighted 5 for 1st choice, 4 for 2nd, 3 for 3rd, 2 for 4th, and 1 for 5th. Results for any diver could thus have a range of 0 - 15.

Several of the aquanauts expressed surprise at the group cooperation and spirit, "I personally was amazed at how well we did get along under such cramped conditions. It seemed to me everybody just went out of their way to be nice." Another diver commented, "There wasn't a cross word said between nobody down there in the 15 days I was there and if you come down to it, that's pretty remarkable."

The "common fate" aspects of being separated from the world by 200 impenetrable feet of water were emphasized by several men who reported feelings of isolation from the outside world. One amusing instance of this was a period of referring to surface personnel as "earth people." On one occasion a diver, in his squeaky, Donald Duck voice, said "I have a message for the earth people. Fuck you!"

A comparison of team cohesiveness scores indicated that Team I showed the greatest increase in cohesiveness and Team II, the smallest. (Team I means, 5.5, Team II, 2.2). The difference between teams did not reach the 5% level ($\underline{t} = 1.58$, $\underline{p} > .10$).

Observation by closed-circuit television supported a view that Team I was somewhat more cohesive than Team II and that Team III was intermediate. Divers on Team I spent more time interacting as one large group -- sitting around the laboratory area eating or engaging in conversation. There was little evidence of pairing in this group. In Team II, on the other hand, while there was no overt bickering, there appeared to be less total group activity and more interaction among pairs of divers. The observed group differences were, however, slight.

Team I might be expected to have a stronger sense of group identity,

having been the first group to face the experience. However, being the first group was not reflected in a higher mean level of fear and arousal for Team I (Team I: fear, 25.10, arousal, 21.30; Team II: fear, 26.00, arousal, 19.55).

An attempt was made to see if level of reported fear was related to attraction to the group, as reported extensively in the clinical literature (Grinker & Spiegel, 1945; Melita Schmideberg, 1942; Stouffer, et al., 1949). Each item was dichotomized on reported fear and mean choices o team mates compared. The results were in the expected direction (low fear mean: 7.57; high fear mean: 9.07) but did not reach the 10% level. It is perhaps reasonable to expect little differential effect of level of fear on attraction to the group at the high levels of stress found in this experience.

2. Expression of dependency on the leader. The primary test of the hypothesis that stress increases dependency on the leader was envisioned in the design as an evaluation of communications directed towards the leader. The previously mentioned difficulty in comprehension of helium speech made such systematic observation impossible. As a result, the data bearing on the hypothesis are circumstantial.

Some support for the suggested increase in dependency can be found in the sociometric data for leader choice after return to the surface. Divers chose their own team leader to a greater extent than they chose any other aquanaut.

The leader of Team I had a sociometric choice score of 31 from his team mates, while the next highest choice had a score of

12.[10] For the leader of Team II, the corresponding scores were 31 and 10, and for the Team III leader, 24 and 16.

Evidence that the choice of own leader was a response to fear can be found by dividing each team at the median on reported fear and comparing sociometric choice of own leader by divers above and below the median on fear. When this is done, it is found that 69% of the aquanauts below their team median on reported fear chose their own leader after the SEALAB experience, while 94% of those above the median on fear chose their own leader as preferred leader of another SEALAB. However, the chi square for this contrast reaches only the 15% level. Thus, the hypothesis is not supported by this analysis.

Another approach to the issue of leadership is to look at the characteristics associated with choice as a leader. Leadership choice scores are available for each man based on the Leader Choice sociometric questionnaire administered after return to the surface. As each aquanaut made five choices for team leader, a leadership score was obtained for each man. These scores were the sum of choices for each man weighted for rank. It is possible, then, to consider various hypothesized reasons for choosing a leader and to see whether these are related to actual choice. The intercorrelations of all a priori variables used in the leadership analysis are presented in Table 8.

(a) Two possible criteria which might be used to choose a leader

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[10] As with the peer sociometric scale, scores were weighted with first first choice = 5, 2nd = 4, 3rd = 3, 4th = 2 and 5th = 1. As a result, the possible range of scores for leader's nine team mates was 0 - 45.

12.[10] For the leader of Team II, the corresponding scores were 31 and 10, and for the Team III leader, 24 and 16.

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Table 8

Intercorrelations of Items Related to Leader Choice

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.	Leader Choice	1.00									
2.	Age	.51**	1.00								
3.	Diving Experience	.22	.67**	1.00							
4.	Maturity	.41*	.26	.11	1.00						
5.	Choice as a peer	.24	.28	.14	.09	1.00					
6.	Fear	-.25	-.11	.01	.05	-.22	1.00				
7.	Arousal	-.21	-.20	-.17	-.10	-.47*	.56**	1.00			
8.	N performance tests	-.07	.00	-.21	.14	-.02	-.25	-.14	1.00		
9.	Diving time	-.03	-.04	.01	.15	.23	-.50**	-.52**	.22	1.00	
10.	N sorties	.11	.13	.14	.10	.33	-.44*	-.47*	.09	.39**	1.00

* $p < .05$

** $p < .01$

are experience and performance. These are certainly criteria which are used by high command in assigning leaders for subordinate units. If followers were to apply these criteria, then choice should show a high positive correlation with years of diving experience and the performance criteria. The results indicate clearly that these factors are not associated with sociometric choice as a leader. The correlations with choice are: Years of diving experience (.22); number of psychological performance tests (-.07); diving time (-.03) and number of sorties (.11). Divers then, did not consider experience and performance as important determinants of a desirable leader.

(b) A preferred leader might be one who can provide a lower fear model for his men. Rabbie's (1961) finding that a person in a state of lower fear was desired for affiliation would support this view. The lower fear leader could provide a source of reassurance and social support. If this motive were operating, one would expect a high negative correlation between leader choice and fear and arousal. Again the data do not support this view. The correlations with choice are: fear (-.25) and arousal (-.21). Thus, divers preferences for a leader were not significantly related to the chosen leader's levels of fear and arousal. It must be noted, however, that the measures of fear and arousal are subjective (i.e., based on self-report) and that divers in choosing might base their judgment on external signs of stress. This point can only be clarified by further investigation, for example, by asking men to estimate the levels of fear and arousal of other group members. Observation of the men, however, impressed the author with

the fact that self-report was closely related to external manifestations of stress.

(c) The most preferred leader might be one who greatly emphasized social interaction. That is, a leader who serves as a "social emotional specialist" (Bales, 1958) concerning himself with the social aspects of the group experience. In this case, leader choice should show high positive correlations with sociometric choice as a peer, gregariousness and participation in meal preparation. Choice should also show a high negative correlation with communications outside SEALAB, as the "social emotional specialist" should direct his social concern towards the group. The results do not support the social interpretation. Choice as a peer and choice as a leader were not significantly correlated (r = .24). This is similar to a finding of Hollander and Webb (1955) that chosen leaders were not highly chosen as peers. The correlation between leader choice and gregariousness was (-.13) while that with meal preparation was (-.15) and with communication outside the group (-.29). The social behavior of an individual in the restricted environment of SEALAB, then, was not related to his desirability as a leader in the eyes of his peers.

(d) The hypothesis of a dependency reaction in the stressful situation was supported by two significant correlations. Choice as a leader was significantly, positively correlated with age (.51, $p < .01$) and with score on the pre-test maturity scale (.41, $p < .05$).

The picture of the desired leader which emerges is of an older, mature, perhaps aloof man rather than someone more social, fearless

and high performing. In relation to other groups which face high stress as a unit, this leadership pattern is more reminiscent of senior echelon leadership than of operational commanders. That is, this type of leader is more similar to the battalion commander or ship captain who remains isolated from his men and exerts indirect authority than to the platoon leader or leading petty officer who works and interacts directly with his subordinates.

One can speculate that in a group retaining direct contact with other units, the immediate leader can fill social and task needs while regressive and dependent needs can be projected onto a more remote senior commander who serves as a father surrogate. Indeed, too much interaction with such a figure might impair his projective utility. In a group which is irrevocably isolated, however, such needs could only be filled by someone with whom contact is possible.

While this is highly conjectural, it can be subjected to test by comparing preferred leader traits in isolated and non-isolated groups under stress. It does seem apparent, however, that the leader in a group facing stress must serve needs beyond group performance and social interaction under stress.

3. Decrease in heterogeneity of emotional response over time. It was proposed that continued exposure to stress as a group should result in a decrease in the heterogeneity of emotional response over time, using the mood checklist as the indicator of emotional response. This hypothesis was based on the assumption that social comparison processes would lead to a more uniform definition of the situation and of personal reactions.

Evaluation of the hypothesis was through comparison of the variances of the mood checklist scales across the three 5-day blocks. The data clearly fail to support the hypothesis. The general trend is towards increased variance in mood by the third 5-day block. The variances across blocks are presented in Table 9.

A number of factors may have been responsible for the failure of the group to achieve greater homogeneity after 15 days of common exposure to high stress. The level of stress may have been too high to permit effective emotional comparison or wide divergencies in initial emotional response to the stressful environment may have resulted in the formation of disparate subgroups which achieved greater homogeneity.

Another alternative may be that group pressures created an illusion of homogeneity which was not reflected in subjective self-report. That such pressures should exist is likely as a homogeneous group can better serve to defend its members against external threat and to provide reassurance. The rejection of deviates by a group under threat may reflect this need to share a feeling of solidarity and unanimity. Some evidence of this was found in the de-briefing interviews of SEALAB aquanauts; however, no systematic evaluation is possible with the available data.

One diver dscribed the pressure to homogenize, "You always had to have this constant equality." Another mentioned his own efforts, "All in all, you sort of compensate for this, slow people, you sort of give them a hand and try to make things work out even."

The reaction of one aquanaut to his group after returning to the surface was "Every one of those guys down there [was] basically the

Table 9

Variances of Mood Scales by Block

	Block I	Block II	Block III
Anger (14 items)	4.90	7.11	9.16
Happiness (14 items)	23.58	37.32	51.49
Fear (13 items)	5.63	7.93	9.53
Depression (12 items)	1.81	4.69	2.52
Arousal (8 items)	5.26	8.12	14.94
Lethargy (6 items)	1.84	2.97	1.42

same type of person I am. We might not think exactly alike, but we must think alike in many of our ways or we wouldn't be under water."

The perception of homogeneity and its relation to subjective self-report would seem to be a highly promising area for subsequent research on stress. One worthwhile approach would be to compare a subject's ratings of others' emotional state with the subject's own, and with that of the others. If the shared illusion of homogeneity is a characteristic group dynamic response to stress, greater distortion of the perception of others should appear under high stress than under low stress, and this distortion should be in the direction of perceived similarity.

Within the framework of the present study, it would appear justified only to state that subjective reports of emotional responses did not become more homogeneous under continued exposure to stress.

Individual Responses to Stress

1. Relationship between stress level and performance. The hypothesis of a relationship between stress reported on the mood checklist and performance was strongly supported by the data. The reliability of the mood checklist stress scales was assessed by computing the Alpha coefficients (Cronbach, 1951) for each block. The Alpha coefficients for fear were: Block I (.64); Block 2 (.63); Block 3 (.65). The Alpha coefficients for arousal were: Block 1 (.79); Block 2 (.86); Block 3 (.88). Reliability of the three performance indices was determined by computing the Alpha coefficients across the three 5-day blocks. These were: number of psychological performance tests (.50) diving time (.83); and number of sorties (.80).

The intercorrelations of all measures used in evaluating performance are presented in Table 10. Of particular interest is the fact that neither age nor diving experience was significantly correlated with any of the performance criteria. The correlations with age were: number of psychological tests (.00); diving time (-.04) and number of sorties (.13) while with years of diving experience they were: number of performance tests (-.21); diving time (.01); and number of sorties (.14). The failure of these two variables to correlate with performance suggests the importance of motivational and emotional factors in determining success in the SEALAB environment.

The correlation between reported fear, diving time and N sorties were -.50 ($p < .01$) and -.47 ($p < .05$). Clearly, the divers who reported themselves to be frightened and aroused dove less and ventured from the capsule less frequently than their less frightened and aroused team mates.[11]

The criterion of number of psychological performance tests completed was almost orthogonal to diving time and number of sorties; fear and arousal were not significantly correlated with this measure (the rs were -.25 and -.11). One correlation with this criterion seems to indicate the nature of this measure. The index of participation in meal preparation was highly correlated with number of performance tasks completed ($r = .64$, $p < .01$). This implies that completing the psychological

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[11] As can be noted in Table 10, diving time and number of sorties are highly correlated (.89). It was thought by the author that these measures might tap different aspects of performance.

Table 10

Intercorrelations of Items Related to Performance and Mood

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1.	Age	1.00													
2.	Diving Exper.	.67**	1.00												
3.	Ordinal Position	.32	.25	1.00											
4.	Size of Hometown	.05	.00	-.15	1.00										
5.	Fear	-.11	.01	-.49**	.26	1.00									
6.	Anger	-.07	-.06	.05	-.22	.34	1.00								
7.	Happiness	-.26	-.23	-.53**	.46*	.53**	-.33	1.00							
8.	Arousal	-.20	-.17	-.57**	.19	.56**	-.22	.87**	1.00						
9.	Communication outside SEALAB	-.39*	-.04	-.39*	.23	.40*	.06	.55**	.46*	1.00					
10.	Gregariousness	-.09	.06	.32	-.48*	-.24	.20	-.55**	-.51**	-.18	1.00				
11.	Participation in meal preparation	.16	-.01	.00	.36	-.16	-.21	.22	.13	-.16	-.38*	1.00			
12.	N performance tests	.00	-.21	.49**	.04	-.25	.08	-.09	-.14	-.33	-.07	.64**	1.00		
13.	Diving Time	-.04	.01	.52**	-.48**	-.50**	.20	-.52**	-.52**	-.50**	.50**	-.10	.22	1.00	
14.	N Sorties	.13	.14	.56**	-.37	-.44*	.23	-.48**	-.47*	-.49**	.46*	-.14	.09	.89**	1.00
14.	Choice as a peer	.28	.14	.25	-.21	-.22	.21	-.44*	-.47*	-.41*	.14	.19	-.02	.28	.33

* $p < .05$ ** $p < .01$

performance tests may have been primarily a function of general cooperativeness and helpfulness. In addition, the psychological tests could be performed inside the anti-shark cage just outside the entrance hatch and were the least dangerous activities a diver could undertake in the water.

A multiple regression using fear and arousal as predictors was run to see how much of the performance variance could be accounted for by these two measures. The multiple correlation coefficient with diving time was .58 ($F = 6.24$, $p < .01$) and with number of sorties .51 ($F = 4.50$, $p < .025$).

One question concerning these findings is whether the mood checklist is measuring predispositions of an individual or represents responses to a situation. That is, particular patterns of response to the mood checklist might represent relatively stable personality characteristics associated with superior or inferior performance. An attempt to clarify this issue was made by correlating a mood checklist completed under non-stressful conditions prior to submersion with the performance criteria.[12]

One finding of interest was that while fear and arousal were significantly correlated ($r = .56$, $p < .01$) at the high levels of stress encountered in SEALAB, they were not significantly related at the low stress level of pre-submersion ($r = .19$). The difference between these correlations was significant at the .06 level. One interpretation for

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[12]The reliability of the pre-submersion checklist was assessed by computing the Alpha coefficients for the scales. These were: fear (.59); arousal (.67).

this finding is that although one might be aroused, active or restless without being fearful, it is unlikely that one could be frightened without being in a state of arousal.

Fear on the pre-submersion checklist had the following correlations: number of psychological performance tests (.38); diving time (.23); number of sorties (.18). In addition to their failure to show the same significant correlations as during-submersion reports, the pre- to during-submersion correlations are significantly different -- number of performance tests: $p < .015$; diving time: $p < .003$: number of sorties: $p < .015$. Pre-submersion arousal also fails to correlate significantly with the performance criteria. The correlations are: number of psychological performance tests (-.09); diving time (-.22); number of sorties (-19). The differences between pre- and during-submersion correlations were not significant, however.

The failure of the mood checklist administered prior to the stressful experience to predict performance during the period of stress suggests that the mood scale is a measure of emotional response to a <u>situation</u> rather than a relatively stable measure of pre-disposition or personality.

Additional clarification of the relationship between reported stress and performance may be found by examining the block data. This data may be used in an attempt to determine whether the mood checklists completed inside SEALAB reflected a general response to the stresses beneath the sea or varied in response to changing conditions in the underwater environment. Mood scores from Block 1 were correlated with performance in Block 3, and performance scores in Block 1 with mood scores in Block 3.

These analyses were limited to diving time and number of sorties as most of the psychological performance tests were conducted during Block 2.

The results for fear indicate that its level at one period in time is related only to performance at the same time. It appears to be limited to the situation at hand. The correlations between Block 1 fear and Block 3 diving time and number of sorties were -.07 and -.12, while the correlations between Block 3 fear and Block 1 diving time and number of sorties were .00 and .03.

Arousal, however, presents a different pattern of correlations. The correlations between Block 1 arousal and Block 3 diving time and number of sorties were -.54 ($p < .01$) and -.46 ($p < .025$) while those between Block 3 arousal and Block 1 performance were -.32 ($p < .10$) and -.42 ($p < .05$).

It appears, then, that level of reported fear is related only to performance at the same time it is assessed. That is, an individual's fear at one time is unrelated to his performance at a different point in time. With arousal, however, one appears to be dealing with a more stable individual phenomenon. A diver's level of arousal in response to the SEALAB environment was significantly correlated over time with performance -- both backward and forward in time. This relationship, however, seems to be only in response to the stressful environment as no such significant relationship existed between pre-submersion arousal and performance in the stressful situation.

The mood checklist appears to be an excellent indicator of perceived

stress and the results provide considerable evidence for a hypothesized relationship between perceived stress and performance. The fact that more than 25% of the variance on performance criteria could be accounted for by the self-report mood scales suggests that these measures may be of great value in assessing responses to stressful situations. Before such a belief can be confirmed, however, much additional research is required. In particular, these measures should be applied in a wide range of stressful situations to determine the generality of the relationship.

The mood checklist should also be administered repeatedly to the same individuals over a wide range of objective stress to attempt to evaluate the hypothesis of a curvilinear relationship which may exist between an individual's level of stress and performance.

Another important question which must be investigated is the relationship between this self-report measure and physiological indices used to assess level of stress. In particular, investigations should be conducted which contrast self-reported stress with such measures as amount of circulating adrenal cortico-steroids, galvanic skin resistance, peripheral vasoconstriction and heart rate.

The major requirement for the adequate evaluation of relationships between stress and performance is a situation where a real, high level of stress exists and where a reliable, objective criterion of performance can be employed. The author plans to extend this study to a number of military situations which meet this requirement. These include training of aircraft carrier jet pilots, paratroop training, qualification of

underwater demolition teams and training in shipboard firefighting.

2. Relationship between birth order, fear and performance. The proposition that first-born and only children would show greater fear and inferior performance in SEALAB is strongly supported by the data. There were 16 first-born and only children and 12 later-borns among the aquanauts. Means for first- and later-borns are shown in Table 11 while correlations are summarized in Table 10.

First-borns reported significantly more fear and arousal, while logging less diving time and making fewer sorties from SEALAB. They failed to differ significantly from later-borns only on the criterion of number of psychological performance tests completed. This finding for level of fear clearly replicates laboratory studies of fear (Darley & Aronson, 1966; Helmreich & Collins, 1966; Schachter, 1959; Zimbardo & Formica, 1963). It also strongly replicates Torrance's (1956) study of Korean fighter pilot effectiveness (as re-analyzed by Schachter, 1959).

Birth order had the following correlations with the stress indices: fear (-.49, $p < .01$) and arousal (-.57, $p < .01$). The correlations with performance criteria were: number of performance tests (.09, n.s.); diving time (.52, $p < .01$); and number of sorties (.56, $p < .01$). The effect is, thus, a strong and highly significant one.

Despite the large differences in emotional response and performance, first- and only-borns differed from later-borns on only one of the pre-submersion measures - compulsivity, showing a lower level of this trait than later-borns. Means for first- and later-borns on demographic and personality variables are presented in Appendix E.

Table 11

Mood and Performance Means for First- and Later-Borns

	First- and Only-Born (N = 16)	Later-Born (N = 12)
Fear	0.83	-.98
Arousal	1.22	-1.79
N performance tests	1.27	1.28
Diving time	-5.53	9.24
Number of sorties	-1.14	0.27

Birth order effects represent an extremely confusing phenomenon in psychology. A large number of studies have found significant differences between first- and only-borns and later-borns on a wide range of variables. A recent article by Altus (1966) reviews a number of these findings. In particular, first- and only-borns achieve eminence more than later-borns (Schachter, 1963) and are overrepresented in the college population (Altus, 1966). In addition, first-borns are more likely to volunteer for psychological experiments (Capra & Dittes, 1961) and also for such a hazardous undertaking as space flight (Perry, 1966). Attempts to isolate ordinal position differences in personality and developmental factors have generally resulted in confusing and contradictory findings. Altus (1966) sums up the state of current knowledge in a single sentence "Ordinal position at birth has been shown to be related to significant social parameters, though the reasons behind the relations are as yet unknown or at best dimly apprehended."

The replication of Torrance's study showing inferior performance by first-borns under high stress has important implications for authorities selecting men for hazardous occupations. This finding assumes additional importance if it is generally true that first-borns volunteer for such assignments more frequently. The apparent paradox of one volunteering differentially for a task at which one will perform significantly more poorly represents an exciting challenge for research.

Two other aspects of the ordinal position phenomena present in this study raise vital questions which can only be answered by subsequent research. One question is whether the performance deficit reported is

limited to volunteer populations. Both fighter pilots and aquanauts are members of select, volunteer groups. One can ask whether such clear differences would be present in a non-selected, non-volunteer population. A second question is whether the differential performance of first- and later-borns is limited to situations in which the individual faces stress alone. It is clear that flying a fighter plane is a very solitary pursuit. Diving, moreover, is an equally solitary experience, despite the fact that one customarily dives in the company of others. The lack of diver - to - diver communications and the dense, dark medium heighten a sense of dissociation and isolation. Schachter (1959) has suggested that perhaps the inferior performance of first-borns would not be found in stressful situations where the stress is faced by groups. The stronger desire for affiliation by first-borns under stress may reflect this effect. Where performance differences are as striking as those found by Torrance and in this study, this would seem to be a crucial area for investigation.

3. Relationship of failure to share group reactions and activities with emotional state and performance. It was proposed that failure to share in group activities and reactions while in SEALAB would be associated with impaired performance and increased fearfulness. Three variables were used as indicators of sharing with the group. These were: (a) amount of communication directed outside the group (an index of failure to share with the group); (b) gregariousness (the index of proportion of time spent in interaction with other team members; and (c) participation in meal preparation and clean-up (the number of times a diver worked to prepare and clean-up after meals). The data provide considerable

support for the view that sharing in group responses is related to performance and mood. Intercorrelations of items used in this analysis are presented in Table 10.

Directing communications away from the group was positively correlated with fear (.41, $p < .05$) and arousal (.46, $p < .05$) and negatively correlated with diving time (-.50, $p < .01$) number of sorties (-.49, $p < .01$); number of psychological performance tests (-.33, $p < .10$) and sociometric choice as a peer after submersion (-.41, $p < .05$). The pattern of correlations with communications outside the group suggests that the diver who sought social interaction outside the group was more frightened and aroused than those restricting directing their attention to the primary group and that this diver was a poor performer who was rejected by his peers.

Gregariousness was also associated with performance. Interaction with peers was positively correlated with both diving time (.50, $p < .01$) and number of sorties (.46, $p < .05$). It was not significantly correlated with fear (-.24) but was with arousal (.50, $p < .01$). It was uncorrelated with sociometric choice (.14). Thus the gregarious diver was a better performer and reported being less aroused, but social interaction was not related to being chosen by team mates as a desirable peer for another underwater experience.

Participation in meal preparation cleanup was significantly related only to gregariousness (-.38, $p < .05$) and to number of psychological performance tests completed (.64, $p < .01$). Preparing and cleaning up after meals was not a social activity. The small size of the galley

limited the number of people who could work there and such activity probably reflected more a desire to help than to interact with the group. The high correlation with number of psychological tests completed also seems to indicate that this measure reflected general cooperation more than social behavior. The failure of this measure to correlate with sociometric choice seems to indicate that persons were accepted more on the basis of involvement with the group than helpfulness or interaction.

The mood scale of happiness shows a somewhat unusual pattern of correlations. Self-report of happiness was positively correlated with fear (.53, $p < .01$) and communication with persons outside of SEALAB (.55, $p < .01$). However, there were significant negative correlations of happiness with sociometric choice (-.44, $p < .05$), diving time (-.52, $p < .01$); number of sorties (-.48, $p < .01$) and gregariousness (-.55, $p < .01$). Thus, it appears that the frightened diver who did not share in the group interaction and directed his attention toward the outer world was rejected by his peers, but reported being happy in his underwater environment. This pattern of results suggests a denial reaction by the rejected diver. The group clearly sanctioned the admission of fear, and there is little evidence of any attempts to deny this reaction. However, the aquanaut who was rejected by the group and unable to share in its emotional life may have denied his unhappiness with the experience as a justification for his presence underwater. Communicating with persons outside SEALAB may have reinforced this tendency to deny unhappiness with the situation. Dissonance theory (Festinger, 1957) would predict that the frightened and rejected diver could report greater happiness.

Dissonance reduction could be achieved through cognitions such as "I am really frightened and rejected by the group and I am stuck down here 200 feet underwater -- but I'm really happy with this experience."

Observing the divers in the capsule, one could detect resentment of the diver who directed his attention away from the primary group. Informal observations indicate that the diver who communicated most with the outside world was severely ridiculed by his team mates for his preoccupation with "earth people."

It is impossible to determine causality in the relationship between sharing in group activities and mood and performance in the present study. It can, however, be concluded that group relations are strongly associated with emotional response to stress and performance in the stressful environment.

4. Prediction of performance in SEALAB. Multiple regressions were performed on the three performance criteria using a priori demographic and behavioral variables as predictors in an attempt to see how much of the variance in performance could be accounted for. The independent variables used as predictors were fear, arousal, ordinal position, communication with the surface, gregariousness, and participation in meal preparation and cleanup. The results of the multiple regressions indicate that half of the variance on each of the performance criteria used can be accounted for by six predictors. The multiple correlation of the six predictors with number of psychological performance tests completed was .70 ($F = 3.43$, $df = 6, 21$, $p < .02$). The multiple correlation coefficient for diving time was .72 ($F = 3.77$, $df = 6, 21$, $p < .02$). The six predictors gave a multiple correlation coefficient of .71 with number of

sorties ($\underline{F}$ = 3.49, $\underline{df}$ = 6, 21, $\underline{p}$ < .02). Thus, it appears that a limited number of predictors can successfully predict objective performance under the stressful conditions found in SEALAB II.

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Appendices

Appendices

APPENDIX A

Defining Stress and Stressful Situations

No simple definition of psychological stress has been accepted by social scientists. The definition first employed by the author (Helmreich, 1960) was based on Selyé's (1950) formulations and dealt with stimuli (internal or external) which disrupt homeostasis. Menninger (1954) has used a similar construct to define psychological stress. Withey (1956) points out that calling psychological stress an analogue of Selyé's physiological construct is inappropriate because of the psychologist's inability to specify a psychological equivalent of physiological homeostasis and to deal with complications introduced by higher mental processes. Recently, greater emphasis has been placed on defining situations which are stressful.

Basowitz, et al. (1955) advocate using the term "stress situation" to refer to stimulus conditions which are assumed to arouse an effective response of anxiety in an individual. Such a definition, however, unduly limits the area of investigation. The same stimulus situation may arouse anger directed towards others, anger directed towards the self or anxiety in persons of differing personality constellations (Funkenstein, 1957).

Janis and Leventhal (1966) propose a more general definition. According to these authors "...any change in the environment which typically -- i.e., in the average person -- induces a high degree of emotional tension and interferes with normal patterns of response" is a stressful event. In a similar definition, Scott (1949) describes the stress situation as "one in which adjustment is difficult or

impossible but in which motivation is very strong."

Slotkin (1952) points out two factors, one or both of which are common to all stressful situations: (a) frustration, in which the external situation prevents achieving the goal toward which an ongoing activity is directed; and/or (b) trauma (real or anticipated) in which the situation provides stimuli which are intense enough to disrupt the performance on ongoing activities.

Holtzman and Bitterman (1955), in their review of laboratory studies of stress, have classified stressful stimuli into six classes, all of which contain one or both of Slotkin's factors. The categories are: (a) disruption of physiological homeostasis; (b) unpleasant or physically painful stimuli; (c) distractions, criticisms and time pressures; (d) real, contrived or anticipated failure; (e) social conflict and related procedures; and (f) situations threatening the individual's safety (anticipated danger).

APPENDIX B

Personality Scales

Instructions

Place the number that indicates how much you agree with each statement in the appropriate space on the answer sheet. For example, if you "agree moderately" with the first statement in the booklet, you would place a 2 in the space for Item 1 below. If you "disagree slightly" with the second statement, you would place a 4 on the answer sheet after Item 2, and so on.

1. Agree strongly
2. Agree moderately
3. Agree slightly
4. Disagree slightly
5. Disagree moderately
6. Disagree strongly

The items were scored so that a low score represents agreement with the scale items.

Scale I

Achievement Motivation

1. I like to assume total responsibility for things.
2. I like to stick to a job when everyone else has given up on it.
3. When I fail in a task, I usually double my efforts and try again.
4. I like to keep working on a problem until it is completely solved.
5. The harder the job, the better I like it.

APPENDIX B (Cont.)

6. The type of problem I like best is that which is almost impossible to do.

Scale II

Autonomy

1. I like to do things my own way, even though they turn out badly.
2. I like to criticize people who are in a position of authority.
3. It bothers me when someone tries to tell me what to do.
4. Once I have made up my mind, no one can change it for me.
5. I prefer to do things my own way without regard to what others may think.
6. I like to be able to come and go as I please.
7. I like to feel free to do what I want to do.
8. I like to disregard rules that I consider to be unjust.

Scale III

Succorance

1. I like people who try to cheer you up when you're feeling depressed.
2. I like people to show concern for how I'm getting along.
3. I like other people to tell me how well I've done a difficult job.
4. I like for people to offer help when I'm having difficulty.
5. I enjoy being with the type of person who always tries to be

APPENDIX B (Cont.)

sympathetic.

6. I enjoy being with people who go out of their way to do things for you.
7. I like people to express their sympathy when I am sick.

Scale IV

Compulsivity

1. Any written work that I do I like to have precise, neat, and well-organized.
2. I like to keep records of continuous routine details or events.
3. I like to keep an accurate and up to date record of my personal expenses.
4. I often recopy notes or records in order to make them neater.
5. I like to maintain a filing system for my personal papers.
6. I can't stand leaving something only half done.

Scale V

Need for Activity

1. I usually need more work to keep me busy.
2. I am often very bored.
3. I usually find myself in need of something to do in my spare time.
4. Time passed too slowly to suit me in my last job.
5. I often wish for more excitement.

APPENDIX B (Cont.)

Scale VI

Harm Avoidance

1. At times I have been somehwat afraid of the dark.
2. I would probably be apprehensive if I were alone in an empty house at night.
3. I have avoided passing through certain city districts for fear of being assaulted.
4. Sometimes I fear that I may be injured in an accident.
5. I would be a little afraid if challenged to a fight.
6. I fear certain things such as lightning, high places, rough water, horseback riding, flying, etc.
7. I am sometimes conscious of a vague fear of death.
8. I am afraid of physical pain.
9. Sometimes I have experienced a fear that I might be attacked by someone.

Scale VII

Maturity Scale

(A high score on this scale represents maturity)

1. I get a kick out of keeping people in the dark as to my next move.
2. Since I can't do anything about public affairs, I am not very interested in them.
3.* I dislike guys who are always breaking the rules.

* Scoring reversed.

APPENDIX B (Cont.)

4. I wouldn't mind being feared by other people, if I thought that they respected me.

5.* I enjoy influencing people.

6. I take a lot of chances in driving .

7. I think if given a fair chance I would make a good leader.

8.* At times I have felt I would be a good commissioned officer.

9.* I like to give orders and get things moving.

10. Compromising with others with a different religion or ideals is the same as lowering your own standards.

11. There is a good type and a bad type that almost all people can be separated into.

12.* In most groups that I am in, I usually handle some of the leadership responsibility.

13. If someone does something nice for me, I usually wonder if there is a hidden reason.

14. A man who leaves himself open for it deserves to be taken advantage of.

15. One person is just as likely to get into trouble as another because it is the breaks that count.

Scale VIII

Delinquency Scale

1.* I think I am stricter about right and wrong than most people.

* Scoring reversed.

APPENDIX B (Cont.)

2.* I often think about how I look and what impression I am making upon others.

3. I never cared much for school.

4. When I meet a stranger, I often think that he is better than I am.

5.* I have never done any heavy drinking.

6.* My table manners are not quite as good at home as when I am in company.

7. I have used alcohol excessively.

8. I often act on the spur of the moment without stopping to think.

9. I often feel that I made the wrong choice in my occupation.

10.* Most of the time I feel happy.

11. Life usually hands me a raw deal.

12. Sometimes I used to feel that I would like to leave home.

13. A person is better off if he doesn't trust anyone.

14. My parents never really understood me.

15. I never worry about my looks.

16.* I hardly ever get excited or thrilled.

17.* I have never been in trouble with the law.

18.* I keep out of trouble at all costs.

19. When I was going to school, I played hookey quite often.

20.* I get pretty discouraged with the law when a smart lawyer gets a criminal free.

* Reverse scored.

APPENDIX B (Cont.)

21. With things going as they are, it's pretty hard to keep up hope of amounting to something.

22.* The members of my family were always very close to each other.

23. As a youngster in school I used to give the teachers lots of trouble.

24. I sometimes wanted to run away from home.

25. I have had more than my share of things to worry about.

26. I used to steal sometimes when I was a youngster.

* Reverse scored.

APPENDIX C

Means and Standard Deviations of Personality Measures

A. By Team

	Variable		Overall	Team I	Team II	Team III
1.	Theoretical	A-V-L Scale of Values	48.86	48.90	49.22	48.44
	S. D.		7.55	4.51	10.58	7.57
2.	Economic		41.79	40.40	44.56	40.56
	S. D.		8.34	9.19	5.32	9.94
3.	Aesthetic		37.50	36.70	38.78	37.11
	S. D.		9.72	11.57	8.94	9.25
4.	Social		34.91	35.50	30.50	38.67
	S. D.		7.77	9.91	6.46	3.67
5.	Political		44.73	42.70	46.94	44.78
	S. D.		6.30	6.53	5.54	6.69
6.	Religious		32.21	35.80	30.00	30.44
	S. D.		9.53	6.01	11.93	9.90
7.	Insolence		18.68	19.90	18.56	17.44
	S. D.		5.80	5.09	4.69	7.68
8.	Achievement Mot.		14.75	13.40	16.56	14.44
	S. D.		3.86	3.13	4.64	3.40
9.	Autonomy		28.11	27.80	27.78	28.78
	S. D.		4.93	6.44	4.79	3.42
10.	Succorance Need		21.18	20.60	20.22	22.78
	S. D.		4.19	2.84	3.73	5.65

APPENDIX C (Cont.)

	Variable	Overall	Team I	Team II	Team III
11.	Compulsivity	19.25	17.00	21.33	19.67
	S. D.	6.39	5.29	7.02	6.74
12.	Activity Need	18.86	20.10	18.89	17.44
	S. D.	4.47	3.07	5.84	4.30
13.	Harm Avoidance	38.43	42.50	34.00	38.33
	S. D.	7.46	5.44	4.95	9.33
14.	Maturity	65.79	66.60	64.22	66.44
	S. D.	6.08	5.80	7.00	5.81
15.	Delinquency	112.43	118.00	109.89	108.78
	S. D.	13.75	11.54	16.89	11.90

B. Civilians versus Military

	Variable		Overall	Civilians (N = 10)	Military (N = 18)
1.	Theoretical		48.86	54.50 **	45.72
	S. D.		7.55	6.88	6.03
2.	Economic		41.79	40.00	42.78
	S. D.	A-V-L	8.34	7.29	8.92
3.	Aesthetic	Scale	37.50	40.80	35.67
	S. D.	of Values	9.72	7.58	10.47
4.	Social		34.91	32.50	36.25
	S. D.		7.77	7.76	7.67
5.	Political		44.73	44.10	45.08
	S. D.		6.30	6.46	6.38

APPENDIX C (Cont.)

Variable	Overall	Civilians (N = 10)	Military (N = 18)
6. Religious	32.21	28.10	34.50
S. D.	9.53	10.89	8.12
7. Insolence	18.68	18.60	18.72
S. D.	5.81	4.90	6.39
8. Achievement Mot.	14.75	15.20	14.50
S. D.	3.86	4.57	3.52
9. Autonomy	28.11	23.60**	30.61
S. D.	4.93	3.50	3.68
10. Succorance Need	21.18	20.50	21.56
S. D.	4.19	4.81	3.90
11. Compulsivity	19.25	19.40	19.17
S. D.	6.39	6.15	6.69
12. Activity Need	18.86	22.00**	17.11
S. D.	4.47	4.60	3.39
13. Harm Avoidance	38.43	35.90	39.83
S. D.	7.46	6.81	7.61
14. Maturity	65.79	64.60	66.44
S. D.	6.08	6.42	5.96
15. Delinquency	112.43	113.10	112.06
S. D.	13.75	9.47	15.88

** $p < .01$

APPENDIX D

Mood Checklist Scales

Instructions

Below is a list of words describing different kinds of moods and feelings. Indicate how characteristic each word is of how you feel TODAY by placing a 1, 2 or 3 in the blank before each word.

1 = NOT AT ALL 2 = SOMEWHAT OR SLIGHTLY 3 = MOSTLY OR GENERALLY

Mood Scales

I - Anger

1. Raging
2. Boiling Mad
3. Angry
4. Mad
5. Grouchy
6. Irritated
7. Impatient
8. Hopping mad
9. Burned up
10. Hostile
11. Mean
12. Indignant
13. Sarcastic
14. Annoyed.

APPENDIX D (Cont.)

II - Happiness

1. On top of the world
2. Wonderful
3. Joyful
4. Fine
5. Good
6. Pleased
7. Calm
8. Overjoyed
9. Cheerful
10. Happy
11. Lighthearted
12. Satisfied
13. Contented
14. Quiet

III - Fear

1. Terrified
2. Desperate
3. Fearful
4. Alarmed
5. Jittery
6. Apprehensive
7. Indifferent
8. Scared Stiff

APPENDIX D (Cont.)

9. Panicky
10. Afraid
11. Insecure
12. Uneasy
13. Timid

IV - Depression

1. Grief-stricken
2. Miserable
3. Sorrowful
4. Lonely
5. Blue
6. Sad
7. Solemn
8. Hopeless
9. Depressed
10. Despairing
11. Downcast
12. Low

V - Arousal

1. Energetic
2. Lively
3. Refreshed
4. Vigorous

APPENDIX D (Cont.)

5. Alert
6. Steady
7. Restless
8. Active

VI - Lethargy

1. Leisurely
2. Drowsy
3. Lazy
4. Weary
5. Sluggish
6. Inactive

APPENDIX E

First-borns versus Later-borns

Means and Standard Deviations

Variable		First-born	Later-born
1. Age		33.94	36.75
S. D.		5.53	5.31
2. Diving Experience		9.69	12.67
S. D.		5.44	6.16
3. Size of Hometown		3.00	2.83
S. D.		1.26	1.34
4. Theoretical		48.56	49.25
S. D.		8.31	6.74
5. Economic		41.25	42.50
S. D.		6.74	10.39
6. Aesthetic	A-V-L	40.38	33.07
S. D.	Scale	9.97	8.26
7. Social	of	33.50	36.79
S. D.	Values	6.08	9.55
8. Political		44.31	45.29
S. D.		6.51	6.26
9. Religious		32.00	32.50
S. D.		10.03	9.25
10. Insolence		18.75	18.58
S. D.		4.17	7.68

APPENDIX E (Cont.)

Variable	First-born	Later-born
11. Achievement Mot.	14.88	14.58
S. D.	3.67	4.25
12. Autonomy	28.00	28.25
S. D.	5.15	4.84
13. Succorance Need	21.68	20.50
S. D.	4.24	4.21
14. Compulsivity	21.62	16.08
S. D.	6.42	4.98
15. Activity Need	19.06	18.58
S. D.	5.03	3.80
16. Harm Avoidance	28.12	38.83
S. D.	6.69	8.66
17. Maturity	65.88	65.67
S. D.	5.65	6.85
18. Delinquency	109.94	115.75
S. D.	14.07	13.14

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13. ABSTRACT

This study was an investigation of individual and group reactions to extreme, prolonged stress in a field situation conducted as part of Project SEALAB II. The 28 divers completed personality and demographic questionnaires prior to submersion. While underwater, they filled out checklists and were continuously monitored by closed-circuit audio and television. Divers underwater were significantly more fearful and aroused than on the surface prior to submersion. The three 10 men teams which lived together underwater became significantly more cohesive after submersion. Evaluation of sociometric choices of leaders indicated that age and maturity were the only characteristics associated with being chosen as a leader. Performance, fear, arousal, gregariousness and choice as a peer were not related to leader choice. Self-reported fear and arousal were significantly correlated with performance criteria. The more frightened and aroused divers demonstrated inferior performance. First-born and only children were significantly more frightened and showed significantly poorer performance than later-borns. Failure of an individual to share in group activities and social behavior was associated with higher levels of reported stress and inferior performance. Using six predictors in a multiple regression, it was possible to account for 50% of the variance of each of three objective performance criteria.

14. KEY WORDS

SEALAB
Stress
Performance
Mood
Leadership
Sociometric choice
Group cohesion
Birth order
Shared affect

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